pound." But in past centuries castoreum was considered a sovereign remedy for every kind of disease. Many amusing details on this part of the subject are given by Mr. Martin, mostly extracted from the "Castorologia" of Johannes Francus, published in 1685. The wisdom of Solomon himself is attributed by this learned author to the virtues of the beaver. To acquire it, it is only necessary "to wear a hat of beaver's skin, to rub the head and spine with that animal's oil, and to take twice a year the weight of a gold crown piece of castoreum."

At the end of his volume Mr. Martin places a short account by Mr. C. V. Riley, the well-known American entomologist, of *Platypsillus castoris*, a parasite on the beaver, and one of the most remarkable among the many extraordinary forms of parasitic insects. Mr. Riley correctly refers this creature to the coleoptera, although other naturalists, and, amongst others, its discoverer, Ritsema, have expressed different views on this point He omits, however, to refer to the excellent account of *Platypsillus castoris*, written by the late John Leconte, and published in the Proceedings of the Zoological Society of London for 1872. Dr. Leconte has here shown that it is necessary to make a special family (Platypsillidæ) for the reception of this curious parasite, but that it must be unquestionably referred to the coleoptera.

On account of these and other peculiarities the beaver is unquestionably an animal of great general interest, and Mr. Martin has done well to devote a volume to what is evidently his favourite theme. There is, we must allow, little, if anything, original in it, and the statements on scientific points cannot always be implicitly depended upon. But the author has brought together a large amount of information on the subject, and his book is "popularly written" and "fully illustrated," though we cannot quite agree to his claims to have produced an "exhaustive monograph."

An Atlas of Astronomy. By Sir Robert Stawell Ball, LL.D., F.R.S. (London: George Philip and Son, 1892.)

A NEW book by Sir Robert Ball is always a matter of interest, but the present one naturally lacks the usual characteristics. It is described as "a series of 72 plates with introduction and index." In addition to monthly and general maps of the stars, the atlas reproduces pictures of the sun, moon, planets, and comets, and contains diagrams illustrating their motions and dimensions. As the book is chiefly meant to be a companion to more general works, the introductory matter is purposely brief, but still it has several features of interest. Special attention may be drawn to the excellent description of a simple graphical method of determining the orbit of a binary star.

To the serious student who may possess a small telescope the new atlas will be very useful. Here he may learn how to determine the positions of sun spots, how to find the places occupied by the various planets, and what objects are most likely to be within reach of his instrument. Those interested in selenography will derive much assistance from the twelve plates showing the moon at different phases, which have been specially drawn by Mr. Elger, each being accompanied by an index map. One can only wonder, however, that some of the recent excellent photographs of the moon have not been pressed into the service.

The star maps, on the whole, are excellent, and our only complaint is of the excessive density of the Milky Way, which, in some parts of the maps, is almost sufficient to obliterate the names and numbers of the stars. The monthly maps will be particularly useful to those who are just learning the constellations, a new feature being a belt indicating the track of the planets.

Spectroscopic astronomy is entirely omitted, the author being of opinion that this great branch of work can only receive justice in a separate atlas. In this we heartily agree, and trust that such an atlas will soon be forthcoming.

The author's large following of readers will no doubt welcome the new comer, but we must express regret that astronomical photographs are not more fully represented. It would be interesting, for example, to reproduce a series of photographs of typical nebulæ, all of which, we believe, are now available. A plate showing the advantages of photography in the delineation of stars would also add to the interest of the atlas.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Vector Analysis.

I FANCIED that, in reply to the voluminous letters of Prof. Willard Gibbs (NATURE, xliii. 511; xliv. 79), I had said in a few words all that is requisite (if, indeed anything *be* requisite) to show the necessary impotence, as well as the inevitable unwieldiness, of every system of (so-called) *Vector Analysis* which does not recognize as its most important feature the product (or the quotient) of two vectors:—*i.e.* a Quaternion.

A recent perusal of the first four pages of a memoir by Mr. O. Heaviside (*Phil. Trans.* 1892):—for so far only could I go:—has dispelled the illusion. For he calls the correspondence just spoken of a "rather one-sided discussion":—a truly Delphic delivery:—cleared up, however, by what follows it. I particularly desired to read the memoir (which the Author had kindly sent me) as I hoped to learn from it something new in Electrodynamics. But, on the fifth page, I met the check-taker as it were:—and found that I must pay before I could go further. I found that I should not only have to unlearn Quaternions (in whose disfavour much is said) but also to learn a new and most uncouth parody of notations long familiar to me; so I had to relinquish the attempt. In the last of the four pages of my progress, I had found that Mr. Heaviside (though, as above stated, he has a system of his own) is an admirer of Prof. Gibbs' system, to such an extent at least that he thinks "his treatment of the linear vector operator specially deserving of notice." There I was content to leave the matter.

But Mr. Heaviside has just published (*Electrician*, 9/12/92) an elaborate attack on Quaternions, of a kind which is calculated to do real injury to beginners. In answer to his remarks, in which he continues to point to me as the persistent advocate of a system which all right-minded physicists should avoid, I would simply refer him (and his readers, if there be such) to a brief Address which I gave a short time ago to the Physical Society of Edinburgh University (*Phil. Mag.* Jan. 1890). One or two sentences, alone, I will quote here:—

"if we can find a language which secures, to an unparalleled extent, compactness and elegance, and at the same time is transcendently expressive—bearing its full meaning on its face—it is surely foolish, at least, not to make habitual use of it."

"For (Hamilton) the most complex trains of formulæ, of the most artificial kind, had no secrets:—he was one of the very few who could afford to dispense with simplifications: yet, when he had tried quaternions, he threw over all other methods in their favour, devoting almost exclusively to their development the last twenty years of an exceedingly active life."

The main object, however, of my present letter, is to call attention to a paper by Dr. Knott, recently read before the Royal Society of Edinburgh. Dr. Knott has actually had the courage to *read* the pamphlets of Gibbs and Heaviside; and, after an arduous journey through these trackless jungles, has emerged a more resolute supporter of Quaternions than when he entered. He has revealed the (from me at least) hitherto hidden mysteries of the Dyadic, and of Prof. Gibbs' strange symbols Pot, Lap, Max, New, &c. The first turns out to be only the linear and vector function; and the others are merely more or less distressing symptoms characteristic of imperfect digestion or assimilation of ∇. And when, at my request, Dr. Knott

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translated into intelligible form the various terms of one of the less formidable formulæ of Mr. Heaviside's memoir, I was surprized to find two old and very unpretending friends masquerading in one person like a pantomime Blunderbore. In one of his Avatars the monster contains, besides the enclosing brackets, no fewer than 24 letters, 12 suffixes, 3 points, and 5 signs! When he next appears he has still the brackets to hold him together, but although he has now only 18 letters, he makes up his full tale of 44 (or 46) symbols; for he has 9 suffixes, 3 indices, 3 points, 5 signs, and 3 *pairs* of parentheses! I used to know him as compounded of 14 separate marks only, viz.:— $V^2\nabla\sigma + 2S\nabla\nabla_1 S\sigma\sigma_1$:—but, unless I had required to dissect him, I should never have put him in anything resembling his new guise.

Dr. Knott's paper is, throughout, interesting and instructive:—it is a complete exposure of the pretensions and defects of the (so-called) Vector Systems. "Wer diesen Schleier hebt soll Wahrheit schauen!" I find it difficult to decide whether the impression its revelations have left on me is that of mere amused disappointment, or of mingled astonishment and pity.

P. G. TAIT.

Edinburgh, 24/12/92.

Measurement of Distances of Binary Stars.

WITH reference to Mr. C. E. Stromeyer's letter on the above subject, which appeared on p. 199, it may be of interest to point out that his plan of determining the distance of a binary star is by no means a new one.

The method was, I think, first suggested by Mr. Fox Talbot at the Edinburgh meeting of the British Association in 1871; but the mere idea was sufficiently obvious as soon as the possibility of determining velocities by the spectroscope had been demonstrated by Dr. Huggins.

The first discussion of the geometrical conditions of the problem was given by Prof. G. Niven in the *Monthly Notices*, vol. xxxiv. No. 7, where he exhibits the relation connecting the parallax, the relative velocity, and the elements of the orbit of a double star, and computes the value of the product (πV) of the parallax and velocity for a small number of binary systems.

In a paper published in the Proceedings of the Royal Irish Academy for May, 1886, I examined the same question from a slightly different point of view, being at the time unaware of Prof. Niven's paper, and was led to similar results. An epitome of this paper was published in your Astronomical Column, vol. xxxiv. p. 206. From the results obtained it appeared that, all things considered, γ-Coronæ Australis and α-Centauri were the most likely binaries to yield to this method of eliciting the secret of their parallax, while α-Geminorum, one of the stars selected by Mr. Stromeyer, was shown to be most unfavourable on account of the situation of its orbit.

In the *Monthly Notices* for March, 1890, I again drew attention to the subject in view of the accuracy of the results obtained by the photographic method in the hands of Prof. Pickering and Prof. Vogel. In this paper I gave an extended list of binaries with the usual geometrical and dynamical elements, and in addition the two elements A and B on which the relative velocity depends. I also gave the greatest value which πV can attain in each case and the velocity to be expected in the case of those stars whose parallaxes had been determined.

Again in Mr. J. E. Gore's valuable catalogue of Binary Star Orbits, published in the Proceedings of the Royal Irish Academy for June, 1890, columns 18 and 19 are devoted to the constants A and B computed from my formulæ (which I may say ought more properly to be called Prof. Niven's formulæ on account of the priority of his paper) for eighty-one different orbits.

The subject has also been discussed by Miss Clerke in "The System of the Stars," pp. 199–201, where references to most of the original publications will be found.

I may perhaps add that the inverse problem of determining the elements of the orbit from spectroscopic observations alone has also been investigated by me in the *Monthly Notices*, vol. li. No. 5, where I have deduced the principal elements of the orbit of β-Aurigæ, a spectroscopic double which no telescope can divide.

I have been disappointed that astronomers engaged on spectroscopic determinations of stellar velocities have not devoted more attention to observations of already known binaries, which appear to me to offer a promising field of work, and have often regretted that at this observatory we have not the means of undertaking the investigation, and if Mr. Stromeyer's letter has no other effect than to bring the subject once more forward it will have done good service, but I should like to point out that the second of the stars selected by him ought on no account to be taken as a test of the feasibility of the method, since the accurate discussion of the conditions shows that unless this is an exceptionally remote system the velocity must be very small indeed. For instance, assuming Johnson's parallax, viz. 0″·20, the relative velocity of the components amounted last year to only 0·6 miles per second.

In the northern hemisphere the most favourably situated binaries are 70 Ophiuchi, ξ-Ursæ Majoris, and, if Peters' orbit represents the real motion of the pair, 61 Cygni; while for the southern hemisphere special attention ought to be directed to α-Centauri and γ-Coronæ Australis.

In Mr. Gore's Catalogue, referred to above, will be found all the materials for determining when to observe any known binary most favourably in this respect, and for deducing its parallax from the measures obtained, and it ought to be borne in mind before letting the subject sink back once more into oblivion, that, other things being equal, this method is most likely to succeed in the case of the most distant systems, where the parallax is so small that the ordinary trigonometrical method necessarily fails us, and that when the micrometer, the heliometer, and the stellar photograph break down, the spectroscope will sound the further depths with ever-increasing facility.

Dunsink Observatory, co. Dublin. ARTHUR A. RAMBAUT.
December 30.

December Meteors (Geminids).

THESE meteors were moderately abundant on the night of December 12, which appears to have been a very favourable one in regard to weather. The chief radiant point was observed in the normal position very close to α Geminorum, and there was a strong contemporary shower from a centre east of β Geminorum.

At 10h. 10m. December 12, a fireball estimated to be twice as brilliant as Venus was observed by Mr. Booth at Leeds. It moved rather slowly from 150° + 43° to 188° + 41°, and divided into two pieces at the finish.

Mr. Wm. Burrows, of Small Lane, Ormskirk, writes to me with reference to a meteorite which he observed to fall at a later hour on the same night. He says the time was 6.52 a.m. (December 13), and refers to the phenomenon as follows:—"Seeing the meteor was coming to the earth I crossed the road to where it appeared to be falling, and it fell about two yards from me. When it struck the earth it made a noise like the report of a gun; it also went black instantly. While descending it had a tail of fire about a foot long. It is 1⅝ inch in diameter one way, and 1¼ inch another, and one inch thick."

Mr. Burrows sends drawings of the object, and it being still in his possession it is hoped the matter may be suitably investigated. Should it prove a veritable meteorite one interesting circumstance in connection with it will be that its descent took place concurrently with the shower of Geminids.

It is significant that December 9–13 constitutes a well-defined ærolitic epoch, rendered memorable by the fall at Wold Cottage, Thwing, Yorkshire, on December 13, 1795, and by many others, such as that at Mässing, Bavaria, December 13, 1803, at Weston, Connecticut, U.S.A., December 14, 1807; at Wiborg, Finland, December 13, 1813; at Ausson, France, December 9, 1858; at Baudong, Java, December 10, 1871, &c.

Bristol, January 1. W. F. DENNING.

The Earth's Age.

AS Dr. Wallace (NATURE, p. 175) trusts "that on further consideration" I shall "admit that" my "objection is invalid," it is evident that I have failed to make clear to him my argument showing that his data do not warrant his conclusion.

He overlooks the fact that a thickness of 177,200 feet of sedimentary rocks is, standing alone, a perfectly indefinite quantity; to make it definite it must have a definite area.

As he mentions no area for it we are justified in assuming that he means the land area of the globe, whereas his calculation is made as though area were not of the essence of the problem, in short, as if the formation of a pile of sediment 177,200 feet thick, of no matter what area, were the problem.

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